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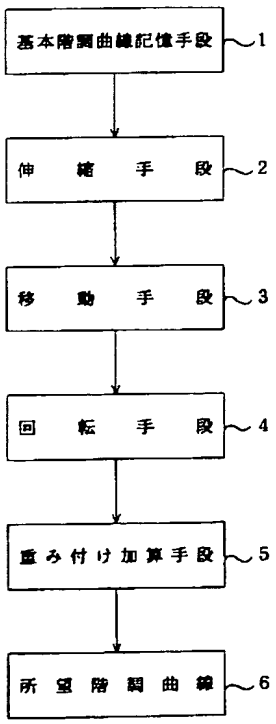
(54)【発明の名称】　階調補正方法および装置

(57)【要約】

【目的】　階調曲線を補正する階調補正方法および装置において、再生画像の最高濃度および最低濃度を設定できるとともに部分的な濃度およびコントラストの調整を行う。

【構成】　基本階調曲線記憶手段１に記憶された基本階調曲線の最低濃度および最高濃度が、所望最低濃度および所望最高濃度となるように伸縮手段２により伸縮し、次いで移動手段３により所定濃度に対応する点が所望とする濃度となるように基本階調曲線を濃度軸に平行に移動させる。移動された基本階調曲線上の所望濃度に対応する点を中心として、この点が所望とするコントラストとなるように回転手段４により基本階調曲線を所定角度回転させ、回転された基本階調曲線の最低濃度および最高濃度がそれぞれ前述した所望最低濃度および所望最高濃度となり、かつ所望濃度に対応する点が所望とする濃度およびコントラストとなるように、重み付け加算手段５により重み付加算し、これにより所望とする階調曲線６を得る。



microscope. The gradation amendment approach and equipment by this invention can obtain not only the class of playback image but the gradation curve considered as a request.
[0053]
[Effect of the Invention] As explained to the detail above, the gradation amendment approach and equipment by this invention Since the point corresponding to the image concentration which the maximum density and the least concentration of a gradation curve after amendment have in the range of request maximum density and the request least concentration, and is considered as a request serves as the concentration and contrast which are considered as a request even if it amends a basic gradation curve, If gradation processing is performed to a picture signal with this gradation curve and this is reproduced, it will be reproduced by the concentration and contrast which are considered as a request, and a playback image can obtain the playback image of the gradation considered as a request.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The block diagram showing the outline of the gradation amendment approach by this invention, and equipment
[Drawing 2] Drawing showing an example of radiation image photography equipment
[Drawing 3] Drawing showing an example of a radiation image reader
[Drawing 4] Drawing showing a basic gradation curve
[Drawing 5] Drawing for explaining telescopic motion of a basic gradation curve
[Drawing 6] Drawing for explaining migration of a basic gradation curve
[Drawing 7] Drawing for explaining rotation of a basic gradation curve
[Drawing 8] Drawing for explaining weighting addition of the basic gradation curve expanded and contracted and the basic gradation curve which rotated
[Drawing 9] Drawing showing the weighting multiplier of weighting addition
[Drawing 10] Drawing for explaining the decision approach of a weighting multiplier
[Drawing 11] Drawing for explaining the decision approach of a weighting multiplier
[Drawing 12] Drawing showing the gradation curve which the output concentration value reversed
[Drawing 13] Drawing showing the gradation curve which amended the reversed concentration value
[Drawing 14] Drawing showing the gradation curve which amended the reversed concentration value
[Drawing 15] Drawing for explaining amendment of the conventional gradation curve
[Drawing 16] Drawing for explaining amendment of the conventional gradation curve
[Drawing 17] Drawing for explaining amendment of the conventional gradation curve
[Drawing 18] Drawing for explaining amendment of the conventional gradation curve
[Drawing 19] Drawing for explaining amendment of the conventional gradation curve

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【特許請求の範囲】

【請求項１】　基準となる基本階調曲線を補正して所望とする階調曲線を得、該所望とする階調曲線に基づいて画像情報を担持する画像信号を所望とする階調により可視像として記録再生する画像記録再生方法における階調補正方法において、

直角座標の一方の軸に前記可視像の濃度をとり、他方の軸に前記画像信号のレベルをとった濃度軸および信号レベル軸からなる信号レベル－濃度座標系において、前記基本階調曲線の最低濃度および最高濃度が、所望最低濃度および所望最高濃度となるように該基本階調曲線を前記濃度軸に沿って伸縮し、

該伸縮された基本階調曲線上の所定濃度に対応する点が所望とする濃度となるように該基本階調曲線を前記濃度軸に平行に移動させ、

該移動された基本階調曲線上の前記所望濃度に対応する点を中心として、該点が所望とするコントラストとなるように該基本階調曲線を所定角度回転させ、

該回転された基本階調曲線の最低濃度および最高濃度がそれぞれ前記所望最低濃度および前記所望最高濃度となり、かつ前記所定濃度に対応する点が前記所望とする濃度およびコントラストとなるように、前記伸縮された基本階調曲線と前記回転された基本階調曲線とを所定の重み付け係数により重み付加算することにより所望とする階調曲線を得ることを特徴とする階調補正方法。

【請求項２】　前記所望階調曲線が、前記所望濃度に対応する点で前記回転された基本階調曲線と滑らかに接するように前記所定の重み付け係数を設定することを特徴とする請求項１記載の階調補正方法。

【請求項３】　前記所望階調曲線が、前記所望最低濃度および前記所望最高濃度に対応する点で前記伸縮された基本階調曲線と滑らかに接するように前記所定の重み付け係数を設定することを特徴とする請求項１または２記載の階調補正方法。

【請求項４】　前記基本階調曲線が複数あり、該複数の基本階調曲線のうち１つの基本階調曲線を選択し、該選択された１つの基本階調曲線の伸縮、移動、回転および重み付け加算を行うことを特徴とする請求項１、２または３記載の階調補正方法。

【請求項５】　前記所望階調曲線を前記基本階調曲線として、該基本階調曲線の伸縮、移動、回転および重み付け加算を繰り返すことを特徴とする請求項１から４のいずれか１項記載の階調補正方法。

【請求項６】　基準となる基本階調曲線を補正して所望とする階調曲線を得、該所望とする階調曲線に基づいて画像情報を担持する画像信号を所望とする階調により可視像として記録再生する画像記録再生装置における階調補正装置において、

直角座標の一方の軸に前記可視像の濃度をとり、他方の軸に前記画像信号のレベルをとった濃度軸および信号レベル軸からなる信号レベル－濃度座標系において、基準となる基本階調曲線を記憶する基本階調記憶手段と、

該基本階調曲線記憶手段に記憶された基本階調曲線の最低濃度および最高濃度が、所望最低濃度および所望最高濃度となるように該基本階調曲線を前記濃度軸に沿って伸縮する伸縮手段と、

該伸縮手段により伸縮された基本階調曲線上の所定濃度に対応する点が所望とする濃度となるように該基本階調曲線を前記濃度軸に平行に移動させる移動手段と、

該移動手段により移動された基本階調曲線上の前記所望濃度に対応する点を中心として、該点が所望とするコントラストとなるように該基本階調曲線を所定角度回転させる回転手段と、

該回転手段により回転された基本階調曲線の最低濃度および最高濃度がそれぞれ前記所望最低濃度および前記所望最高濃度となり、かつ前記所定濃度に対応する点が前記所望とする濃度およびコントラストとなるように、前記伸縮された基本階調曲線と前記回転された基本階調曲線とを所定の重み付け係数により重み付加算する重み付け加算手段とからなることを特徴とする階調補正装置。

【請求項７】　前記重み付け加算手段が、前記所望濃度に対応する点で前記回転された基本階調曲線と滑らかに接するように前記所定の重み付け係数を設定する手段であることを特徴とする請求項６記載の階調補正装置。

【請求項８】　前記重み付け加算手段が、前記所望最低濃度および前記所望最高濃度に対応する点で前記伸縮された基本階調曲線と滑らかに接するように前記所定の重み付け係数を設定する手段であることを特徴とする請求項６または７記載の階調補正装置。

【請求項９】　前記基本階調曲線記憶手段が複数の基本階調曲線を記憶した手段であることを特徴とする請求項７、８または９記載の階調補正装置。

【請求項１０】　前記所望階調曲線を記憶する所望階調記憶手段をさらに設け、

該所望階調記憶手段に記憶された所望階調曲線を前記伸縮手段に入力し、再度前記伸縮手段による伸縮、前記移動手段による移動、前記回転手段による回転および前記重み付け手段による重み付け加算を繰り返す制御手段をさらに備えたことを特徴とする請求項６から９のいずれか１項記載の階調補正装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、画像情報を担持する画像信号を所望とする階調曲線に基づいて可視像として再生する際に、この可視像が目的に応じて見易い階調の画像に再生されるように、基準となる階調曲線を補正して所望とする階調曲線を得る階調補正方法および装置に関するものである。

【０００２】

【従来の技術】画像信号に基づいて変調された光で写真

感光材料を露光し、この写真感光材料に画像を再生記録する画像記録装置が種々の分野で用いられている。

【０００３】たとえば、後の画像処理に適合するように設計されたガンマ値の低いフイルムを用いてＸ線画像を記録し、このＸ線画像が記録されたフイルムからＸ線画像を読み取って電気信号に変換し、この電気信号（画像信号）に画像処理を施した後画像記録再生装置を用いて感光フイルム上に可視画像を再生することにより、コントラスト，シャープネス，粒状性等の画質性能の良好な再生画像を得ることのできるシステムが開発されている（特公昭61-5193 号公報参照）。

【０００４】また本出願人により、放射線（Ｘ線，α線，β線，γ線，電子線，紫外線等）を照射するとこの放射線エネルギーの一部が蓄積され、その後可視光等の励起光を照射すると蓄積されたエネルギーに応じて輝尽発光を示す蓄積性蛍光体（輝尽性蛍光体）を利用して、人体等の被写体の放射線画像を一旦シート状の蓄積性蛍光体に撮影記録し、この蓄積性蛍光体シートをレーザー光等の励起光で走査して輝尽発光光を生ぜしめ、得られた輝尽発光光を光電的に読み取って画像信号を得、画像記録再生装置を用いてこの画像信号に基づき被写体の放射線画像を感光フイルム上に可視画像として出力する放射線画像記録再生システムがすでに提案されている（特開昭55-12429号等）。

【０００５】上述したシステムにおいては、あらかじめ撮影する対象物および各々の目的に適応する濃度－画像信号変換パターンである階調補正パターンを作成しておき、画像情報を担持する画像信号に対してこのパターンに応じた信号変換処理を施すことによって階調処理を行うことが多い。

【０００６】しかしながら、上記の階調処理において多種の撮影対象物および種々の目的に応じた階調補正曲線を作成する場合には、この階調補正曲線が数十種類程度必要になり、この階調補正曲線を作成するための粗データ収集労力およびデジタル変換して記憶させておくための電子計算機等の記憶容量は膨大なものとなり実用上簡便な方法とはいえない。

【０００７】このため、直角座標の一方の軸にこの可視像の濃度をとり、他方の軸にこの画像信号のレベルをとった信号レベル－濃度座標において、基準となる階調曲線を作成し、この座標系において曲線上の一点を中心としてこの曲線を回転かつ平行移動して所定の画像情報および目的に応じた所望の階調曲線を得る階調補正方法が提案されている。

【０００８】また、図15および図16に示すような種々の階調曲線を得るために基準となる階調曲線が所望とするカーブ形状および形状変化の程度を有する階調曲線となるように基準階調曲線の全体的な濃度やコントラストを変化させるようにした階調補正方法が提案されている。

【０００９】この方法では、図17に示すように基本階調曲線（実線で示す）を濃度軸に沿って伸縮した後（破線で示す）に、図18に示すように入力画像信号軸に沿って伸縮させてコントラストを変化させ、これにより所望とする階調曲線を得ている。

【００１０】さらに、図19に示すように、いくつかの特徴的な基本階調を用意しておき、その中から所望の階調に近いものを選択し、選択された階調の強調度（階調曲線の曲り具合の程度）を変えることにより所望とする階調を得る方法が提案されている。この方法では最高濃度、最低濃度を変えることなく階調の強調度を変化させることができる（特開平5-323750号）。

【００１１】

【発明が解決しようとする課題】上述した画像信号を可視像として再生する際には、階調補正方法により補正された階調曲線を調整して再生画像の最高濃度および最低濃度を設定したり、再生画像の部分的な濃度およびコントラストを変化させることにより所望とする階調の画像を得たいという要望が大きかった。

【００１２】しかしながら、上述した基準階調曲線の全体的なコントラストや濃度を調整することにより階調曲線を補正する方法においては、補正後の階調曲線の最高濃度および最低濃度が変化してしまう上に、階調曲線の部分的な補正を行うことができないため、再生される画像を所定の濃度の範囲のものとするとともに、画像の所望とする濃度の部分のみの濃度およびコントラストを変化させたりすることができなかった。また、上述した特開平5-323750号に記載された階調曲線の最高濃度および最低濃度を固定しておいて階調曲線の全体的な曲り具合を変化させる方法では、補正後の階調補正曲線の最高濃度および最低濃度は変化しないが、再生画像の一部分のみの濃度およびコントラストを変化させることができなかった。

【００１３】本発明は上記事情に鑑み、再生画像の最高濃度および最低濃度を設定できるとともに部分的な濃度およびコントラストの調整を行うことができる階調補正方法および装置を提供することを目的とするものである。

【００１４】

【課題を解決するための手段】本発明による階調補正方法は、基準となる基本階調曲線を補正して所望とする階調曲線を得、該所望とする階調曲線に基づいて画像情報を担持する画像信号を所望とする階調により可視像として記録再生する画像記録再生方法における階調補正方法において、直角座標の一方の軸に前記可視像の濃度をとり、他方の軸に前記画像信号のレベルをとった濃度軸および信号レベル軸からなる信号レベル－濃度座標系において、前記基本階調曲線の最低濃度および最高濃度が、所望最低濃度および所望最高濃度となるように該基本階調曲線を前記濃度軸に沿って伸縮し、該伸縮された基本階調曲線上の所定濃度に対応する点が所望とする濃度に

対応する点となるように該基本階調曲線を前記濃度軸に平行に移動させ、該移動された基本階調曲線上の前記所望濃度に対応する点を中心として、該点が所望とするコントラストとなるように該基本階調曲線を所定角度回転させ、該回転された基本階調曲線の最低濃度および最高濃度がそれぞれ前記所望最低濃度および前記所望最高濃度となり、かつ前記所望濃度に対応する点が前記所望とする濃度およびコントラストとなるように、前記伸縮された基本階調曲線と前記回転された基本階調曲線とを所定の重み付け係数により重み付加算することにより所望とする階調曲線を得ることを特徴とするものである。

【００１５】ここで、階調曲線とは、最終再生画像の光学濃度に対する被写体の輝度を光電変換した画像信号レベルの対応を表す特性曲線のことであり、画像を扱う分野において通常用いられているものである。

【００１６】また、本発明による階調補正装置は、上記方法を実施するためのものであり、基準となる基本階調曲線を補正して所望とする階調曲線を得、該所望とする階調曲線に基づいて画像情報を担持する画像信号を所望とする階調により可視像として記録再生する画像記録再生装置における階調補正装置において、直角座標の一方の軸に前記可視像の濃度をとり、他方の軸に前記画像信号のレベルをとった濃度軸および信号レベル軸からなる信号レベル－濃度座標系において、基準となる基本階調曲線を記憶する基本階調記憶手段と、該基本階調曲線記憶手段に記憶された基本階調曲線の最低濃度および最高濃度が、所望最低濃度および所望最高濃度となるように該基本階調曲線を前記濃度軸に沿って伸縮する伸縮手段と、該伸縮手段により伸縮された基本階調曲線上の所定濃度に対応する点が所望とする濃度となるように該基本階調曲線を前記濃度軸に平行に移動させる移動手段と、該移動手段により移動された基本階調曲線上の前記所望濃度に対応する点を中心として、該点が所望とするコントラストとなるように該基本階調曲線を所定角度回転させる回転手段と、該回転手段により回転された基本階調曲線の最低濃度および最高濃度がそれぞれ前記所望最低濃度および前記所望最高濃度となり、かつ前記所望濃度に対応する点が前記所望とする濃度およびコントラストとなるように、前記伸縮された基本階調曲線と前記回転された基本階調曲線とを所定の重み付け係数により重み付加算する重み付け加算手段とからなることを特徴とするものである。

【００１７】さらに、上記方法および装置において、前記所望階調曲線が、前記所望濃度に対応する点で前記回転された基本階調曲線と滑らかに接するように前記所定の重み付け係数を設定することが好ましく、さらには、前記所望階調曲線が、前記所望最低濃度および前記所望最高濃度に対応する点で前記伸縮された基本階調曲線と滑らかに接するように前記所定の重み付け係数を設定することがさらに好ましい。

【００１８】また、記憶手段に前記基本階調曲線を複数記憶させ、該複数の基本階調曲線のうち１つの基本階調曲線を選択し、該選択された１つの基本階調曲線の伸縮、移動、回転および重み付け加算を行うようにしてもよい。

【００１９】さらに、前記所望階調曲線を前記基本階調曲線として、該基本階調曲線の伸縮、移動、回転および重み付け加算を繰り返すようにしてもよい。

【００２０】

【作用】本発明による階調補正方法および装置は、階調補正を行う基本となる基本階調曲線の最低濃度および最高濃度が所望最低濃度および所望最高濃度となるようにこの基本階調曲線を伸縮し、この伸縮された基本階調曲線の観察の対象とすべき所定濃度に対応する点が、所望の濃度およびコントラストとなるようにこの曲線を移動および回転させ、回転された基本階調曲線の最低濃度および最高濃度が所望最低濃度および所望最高濃度となり、かつ所望濃度に対応する点が所望濃度およびコントラストとなるように、伸縮された基本階調曲線と回転された基本階調曲線とを所定の重み付け係数により重み付け加算するようにしたものである。そして、階調曲線の信号値の最低レベルおよび最高レベルの点においては伸縮された基本階調曲線の重み付け係数が１、所望濃度の点においては回転された基本階調曲線の重み付け係数が１となるように重み付け加算することにより基本階調曲線を補正することにより、得られる階調曲線は最高濃度および最低濃度が所望最高濃度および所望最低濃度となり、かつ所望濃度に対応する部分的な点が所望とする濃度および所望とするコントラストを有する曲線となる。

【００２１】したがって、この所望階調曲線に基づいて画像信号を可視像として再生すれば、再生画像は所望最低濃度と所望最高濃度の範囲にあり、かつ観察の対象となる所定濃度に対応する点は所望とする濃度および所望とするコントラストで再生されることとなる。

【００２２】また、上述した放射線画像を再生する場合に限らず、断層撮影により得られた画像、電子顕微鏡像等の撮影する対象が異なる場合であっても、撮影により得られる画像信号の種類に応じて所望とする階調曲線を設定することができるため、再生画像の種類に拘らず所望とする階調の画像を再生することができる。

【００２３】また、所望濃度の点および／または所望最低濃度と所望最高濃度の点において回転された基本階調曲線と所望階調曲線が滑らかに接するように重み付け係数を設定することにより、伸縮された基本階調曲線および回転された基本階調曲線とが滑らかに接することとなり、この階調曲線に基いて再生された可視像は視覚的な印象が自然なものとなる。

【００２４】さらに、基本階調曲線を複数設け、この複数の基本階調曲線から補正をすべき基本階調曲線を選択することにより、補正をすべき基本階調曲線の選択の幅

が広がることとなる。

【００２５】また、補正された所望階調曲線を基本階調曲線として、繰り返し補正を行うことにより、所望階調曲線をさらに所望とする濃度およびコントラストとすることができるため、この補正階調曲線により再生される画像はより観察に適したものとなる。

【００２６】

【実施例】以下図面を参照して本発明の実施例について説明する。

【００２７】図１は本発明による階調補正方法および装置の概略を説明するブロック図である。図１に示すように本発明による階調補正方法および装置は、直角座標の一方の軸に可視像の濃度をとり、他方の軸に画像信号のレベルをとった濃度軸および信号レベル軸からなる信号レベルー濃度座標系において、基準となる基本階調曲線を記憶する基本階調記憶手段１と、基本階調曲線記憶手段１に記憶された基本階調曲線の最低濃度および最高濃度が、所望最低濃度および所望最高濃度となるように基本階調曲線を濃度軸に沿って伸縮する伸縮手段２と、伸縮手段２により伸縮された基本階調曲線上の所定濃度に対応する点が所望とする濃度となるように基本階調曲線を濃度軸に平行に移動させる移動手段３と、移動手段３により移動された基本階調曲線上の所望濃度に対応する点を中心として、この点が所望とするコントラストとなるように基本階調曲線を所定角度回転させる回転手段４と、回転手段４により回転された基本階調曲線の最低濃度および最高濃度がそれぞれ前述した所望最低濃度および所望最高濃度となり、かつ所望濃度に対応する点が所望とする濃度およびコントラストとなるように、伸縮された基本階調曲線と回転された基本階調曲線とを所定の重み付け係数により重み付加算する重み付け加算手段５とからなり、上述した基本階調記憶手段１、伸縮手段２、移動手段３、回転手段４および重み付け加算手段５により基本階調曲線を補正して、所望とする階調曲線６を得るものである。

【００２８】以下本発明の実施例による階調補正装置の概略について説明する。

【００２９】図２は、放射線画像撮影装置の一例を表す図である。

【００３０】この放射線画像撮影装置10の放射線源11から放射線12が人体等の被写体13に向けて照射され、被写体13を透過した放射線12a が蓄積性蛍光体シート14に照射されることにより、被写体13の透過放射線画像がシート14に蓄積記録される。

【００３１】図３は、放射線画像読取装置の一例を表す斜視図である。

【００３２】上記のようにして放射線画像の蓄積記録が行われた蓄積性蛍光体シートがこの放射線画像読取装置の所定位置にセットされる。

【００３３】所定位置にセットされた蓄積性蛍光体シート14は、図示しない駆動手段により駆動されるエンドレスベルト等のシート搬送手段15により、矢印Ｙ方向に搬送（副走査）される。一方、レーザ光源16から発せられた光ビーム17はモータ18により駆動され矢印Ｚ方向に高速回転する回転多面鏡19によって反射偏向され、ｆθレンズ等の集束レンズ20を通過した後、ミラー21により光路をかえてシート14に入射し、副走査の方向（矢印Ｙ方向）と略直角な矢印Ｘ方向に主走査する。シート14の光ビーム17が照射された箇所からは、蓄積記録されている放射線画像情報に応じた光量の輝尽発光光22が発せられ、この輝尽発光光22は光ガイド23によって導かれ、フォトマルチプライヤ（光電子増倍管）24によって光電的に検出される。光ガイド22はアクリル板等の導光性材料を成形して作られたものであり、直線状をなす入射端面23a が蓄積性蛍光体シート14上の主走査線にそって延びるように配され、円環状に形成された射出端面23b にフォトマルチプライヤ24の受光面が結合されている。入射端面23a から光ガイド23内に入射した輝尽発光光22は、該光ガイド23の内部を全反射を繰り返して進み、射出端面23b から射出してフォトマルチプライヤ24に受光され、放射線画像を表す輝尽発光光22がフォトマルチプライヤ24によって電気信号に変換される。

【００３４】フォトマルチプライヤ24から出力されたアナログ信号Ｓは、ログアンプ25で対数的に増幅された後Ａ／Ｄ変換器26に入力されて、蓄積性蛍光体シート14上における所定のサンプリング間隔に対応する時間間隔でサンプリングしてディジタルの画像データＳ１に変換される。この画像データＳ１は、一旦記憶部27に記憶された後、画像処理装置28に送られる。

【００３５】この画像処理装置28は本発明の階調補正装置の一例を内包するものである。すなわち、前述した図１に示す基本階調記憶手段１、伸縮手段２、移動手段３、回転手段４および重み付け加算手段５を内包するものであり、入力手段29からの濃度、コントラスト等の入力により各手段における処理を行うものである。

【００３６】図４は画像処理装置28の基本階調記憶手段１に記憶された基本階調曲線の一例を表す図である。図４に示すように、基本階調曲線Ｋ１は縦軸に可視像の濃度値をとり、横軸に画像信号のレベルをとった濃度軸および信号レベル軸からなる信号レベルー濃度座標系において設定されており、本実施例においては図４に示す基本階調曲線Ｋ１を補正することにより所望とする階調曲線を得るものである。

【００３７】まず、伸縮手段２において基本階調曲線Ｋ１の伸縮がなされる。すなわち、図５に示すように基本階調曲線Ｋ１の最高濃度Ｄmax および最低濃度Ｄmin が入力手段29より入力された所望最高濃度ｄmax および所望最低濃度ｄmin となるように基本階調曲線Ｋ１を濃度軸に沿って伸縮し、伸縮された基本階調曲線Ｋ２を得る。

【００３８】次いで移動手段３において、伸縮手段２により伸縮された基本階調曲線Ｋ２上の所定濃度に対応する点が所望とする濃度となるように基本階調曲線Ｋ２を濃度軸に平行に移動させる。まず、入力手段29より所望とする画像濃度に対応する濃度値Ｄ０を入力するとともに、この濃度値Ｄ０の希望濃度ＤＨを入力する。移動手段３においてはこの入力された濃度値Ｄ０と希望濃度値ＤＨとに基づいて、伸縮された基本階調曲線Ｋ２を濃度軸に平行に移動させるための移動量ΔＤが求められ、図６に示すように伸縮された基本階調曲線Ｋ２を移動させ、移動された基本階調曲線Ｋ３を得る。また、濃度値の入力方法はこれに限るものではなく、例えば濃度値Ｄ０と希望濃度値ＤＨとの差ΔＤを入力するようにしてもよい。

【００３９】次いで、回転手段４において、移動手段３により移動された基本階調曲線Ｋ３上の所望濃度に対応する点を中心として、この点が所望とするコントラスト

$$K5 = W \times K4 + (1 - W) \times K2 \quad \cdots(1)$$

但し　Ｗ：重み係数

の演算がなされ、階調曲線Ｋ５が得られる。ここで、重み係数Ｗの例としては図９に示すものが挙げられる。そして重み付け加算手段５においては重み係数Ｗを用いて式(1) に示す演算がなされ、図８に示すような階調曲線Ｋ５が得られる。

【００４１】ここで、重み係数Ｗは回転手段４により回転された基本階調曲線Ｋ４の最低濃度および最高濃度がそれぞれ所望最低濃度ｄmin および所望最高濃度ｄmax となり、かつ所望濃度に対応する点Ｐが所望とする濃度ＤＨおよびコントラストとなるように、点Ｐ付近では階調曲線Ｋ４の重みが大きく、最高濃度および最低濃度付近では階調曲線Ｋ２の重みが大きくなるように設定され、かつ階調曲線Ｋ５が点Ｐ付近で階調曲線Ｋ４と滑らかに接しかつ最高濃度および最低濃度付近では階調曲線Ｋ２と滑らかに接するように重み付け係数の変化が連続するように設定される。このように重み付け係数を連続的に変化させることにより、補正された階調曲線に基づいて再生される可視像は視覚的な印象が自然なものとなる。

$x < DH_{in}$のとき

$W(0) = 0$	……1.……	$W(DH_{in}) = 1$
$W(DH_{in}) = 1$	……2.……	$W(MAX) = 0$
$W'(0) = 0$	……3.……	$W'(DH_{in}) = 0$
$W'(DH_{in}) = 0$	……4.……	$W'(MAX) = 0$
$W''(k1) = 0$	……5.……	$W''(k2) = 0$
$(0 < k1 < DH_{in})$		$(DH_{in} < k2 < MAX)$

これらの条件式の意味は

１．２．は先に述べた階調曲線Ｋ２の階調曲線Ｋ４の影響力を満たすための条件

３．４．は滑らかな階調を作るための条件

５．は変更した濃度、コントラストが階調曲線Ｋ５に及ぼす影響の度合い調整のための条件である。５．の条件式において、ｋ１，ｋ２をＤＨin側にすれば階調曲線Ｋ５の影響力が強い範囲は狭くなる。

【００４４】この例では変更した濃度、コントラストは階調曲線Ｋ５の全範囲に影響を及ぼしていたが、この影響の及ぶ範囲を限定した重み係数の設定もできる。この例について図11を用いて説明する。今、０からＤＨinまでの範囲をL_1、ＤＨinからＭＡＸまでの範囲をL_2とする。このとき範囲L_1，L_2とで範囲の狭い方の係数を求め、他方の係数についてはＤＨinで対称な係数を設定する。このような重み関数を設定すれば極端に最小（最大）濃度に近い部分の濃度とコントラストの変更をした場合にその影響が最大（最小）濃度側にまで及んでしまうという事態を避けることができ、局所的な階調の変更をすることができる。先に示した図９の重み係数は

【００４２】ここで重み付け係数Ｗの設定の方法について説明する。なお、ここでは重み係数を４次の多項式を用いて求める場合の例を説明するものとし、変更した濃度とコントラストは階調５の全範囲に亘って影響を及ぼすものとする。図10に示すように希望濃度（ＤＨ）に対する入力デジタル値を（ＤＨin）とし、各々の入力デジタル値をｘとする。このとき、ｘ＜ＤＨin，ＤＨin＜ｘの区間でそれぞれ重み係数Ｗ（ｘ）を決める。各区間における重み係数の決定条件は以下のようになる。

【００４３】

この例である。

【００４５】上記の２つの例は４次の多項式を用いて係数を求める方法であるが、重み係数を求める方法はこれに限られるものではなく、他の多項式、三角関数、指数関数などを使用してもよい。

【００４６】また、基本階調曲線Ｋ５の計算方法は重み付け加算に限らず、

【００４７】

【数１】

$$K5 = \sqrt{(K4)^{k} \cdot (K2)^{2-k}} \qquad 0 \leqq k \leqq 2$$

最大、最小濃度付近で　$k \fallingdotseq 0$

希望濃度付近で　$k \fallingdotseq 2$

【００４８】のような式でもよく、入力値に依存して合成比率を変更できるものなら何でもよい。

【００４９】このようにして所望とする階調曲線Ｋ５が得られると画像処理装置28においてこの階調曲線Ｋ５に基づいて画像信号Ｓ１が処理され、処理された画像信号Ｓ２はレーザプリンタやＣＲＴ等の再生手段30に変換され、この再生手段30において可視像として再生される。

【００５０】なお、上述した実施例において求められた所望とする階調曲線Ｋ５を記憶手段27に記憶しておき、この階調曲線Ｋ５を基本階調として上述した伸縮手段２、移動手段３、回転手段４および重み付け加算手段５における処理を施すようにしてもよい。この場合、再度の補正としては前回の補正により設定した所定信号レベルに対応する点とは異なるレベルの点を所望とする濃度およびコントラストとなるように補正することが考えられる。またこの伸縮手段２、移動手段３、回転手段４および重み付け加算手段５における処理を繰り返すようにすれば、所望とする理想の階調に限りなく近い階調曲線を作成することができる。

【００５１】また、本発明においては、極端な階調の補正を行おうとすると、図12に示すように入力画像信号値に対して出力濃度値が単調増加にならない現象が起こることがある。このような場合には、補正後の階調曲線Ｋ５が単調増加となるような対策をとる。例えば図13に示すように濃度値が逆転している区間の出力濃度値を一定値にして階調曲線Ｋ６を得る方法や、図14に示すように出力濃度値が逆転した区間の前後を直線で変換して階調曲線Ｋ７を得る方法等が考えられる。もちろん、対策の方法としてはこれらに限定されるものではなく、階調曲線Ｋ５を単調増加となるように修正する方法であればいかなる方法を用いてもよいものである。

【００５２】また、上述した実施例においては、放射線画像を蓄積性蛍光体シートに記録し、この蓄積性蛍光体シートから放射線画像を表す画像信号を得て、この画像信号に対して階調処理を行う場合の階調曲線の補正について説明したが、これに限定されるものではなく、Ｘ線画像が記録されたフイルムからＸ線画像を読み取ることによって得られた画像信号に対して階調処理を行う場合の階調曲線を補正するようにしてもよい。また、ＣＴスキャン等の断層撮影により得られた画像信号や、電子顕微鏡の撮影により得られた電子顕微鏡像を表す画像信号に対して階調処理を行う場合の階調曲線を補正するようにしてもよい。本発明による階調補正方法および装置は、再生画像の種類に限らず所望とする階調曲線を得ることができる。

【００５３】

【発明の効果】以上詳細に説明したように本発明による階調補正方法および装置は、基本階調曲線を補正しても補正後の階調曲線の最高濃度と最低濃度とは所望最高濃度および所望最低濃度の範囲にあり、かつ所望とする画像濃度に対応する点は所望とする濃度およびコントラストとなるため、この階調曲線により画像信号に階調処理を施してこれを再生すれば、再生画像は所望とする濃度およびコントラストで再生されることとなり、所望とする階調の再生画像を得ることができる。

【図面の簡単な説明】

【図１】本発明による階調補正方法および装置の概略を表すブロック図

【図２】放射線画像撮影装置の一例を表す図

【図３】放射線画像読取装置の一例を表す図

【図４】基本階調曲線を表す図

【図５】基本階調曲線の伸縮を説明するための図

【図６】基本階調曲線の移動を説明するための図

【図７】基本階調曲線の回転を説明するための図

【図８】伸縮された基本階調曲線および回転された基本階調曲線の重み付け加算を説明するための図

【図９】重み付け加算の重み付け係数を表す図

【図１０】重み付け係数の決定方法を説明するための図

【図１１】重み付け係数の決定方法を説明するための図

【図１２】出力濃度値が逆転した階調曲線を表す図

【図１３】逆転した濃度値を補正した階調曲線を表す図

【図１４】逆転した濃度値を補正した階調曲線を表す図

【図１５】従来の階調曲線の補正を説明するための図

【図１６】従来の階調曲線の補正を説明するための図

【図１７】従来の階調曲線の補正を説明するための図

【図１８】従来の階調曲線の補正を説明するための図

【図１９】従来の階調曲線の補正を説明するための図

【符号の説明】

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1　基本階調曲線記憶手段
2　伸縮手段
3　移動手段
4　回転手段
5　重み付け加算手段
6　所望階調曲線

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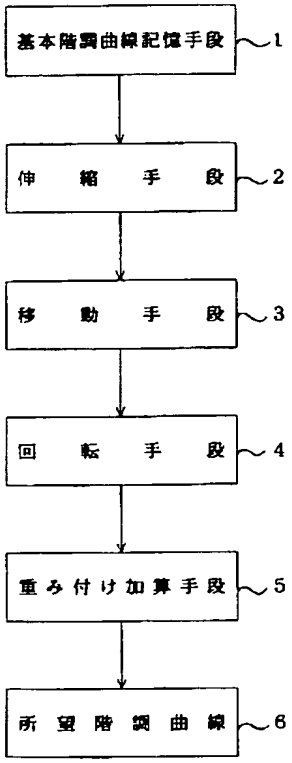
K１　基本階調曲線
K２　伸縮された階調曲線
K３　移動された階調曲線
K４　回転された階調曲線
K５　重み付け加算された階調曲線

【図１】



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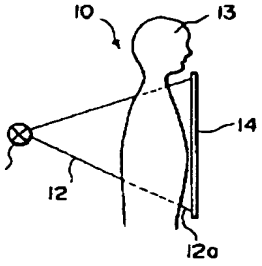

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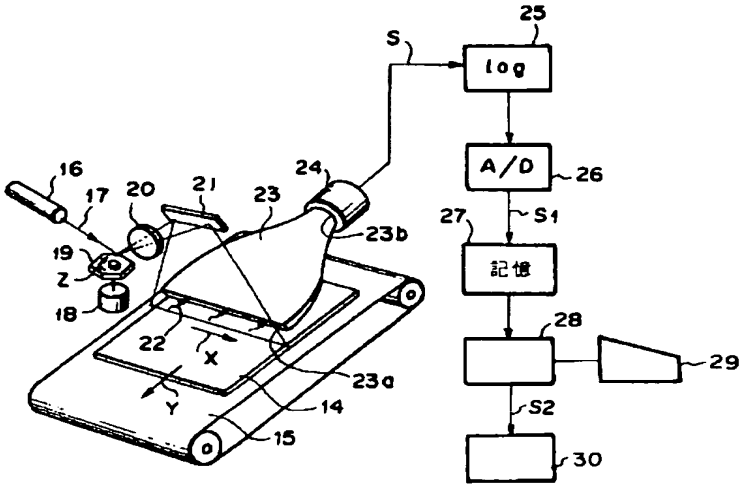

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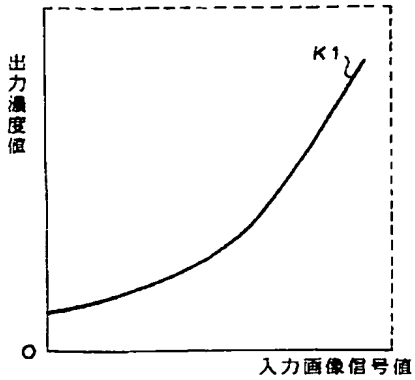

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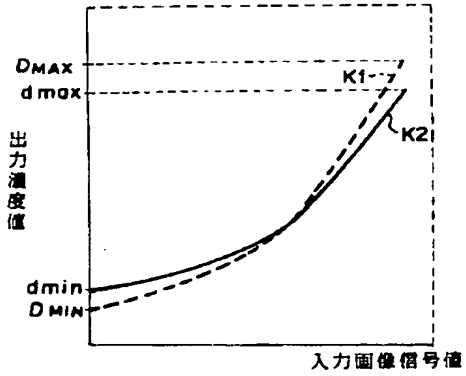

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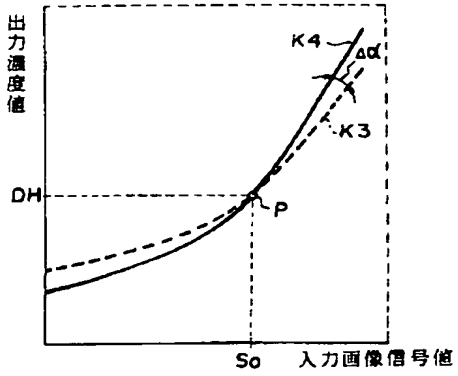

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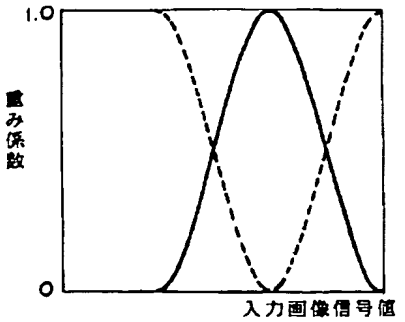

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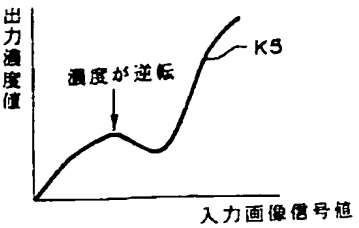

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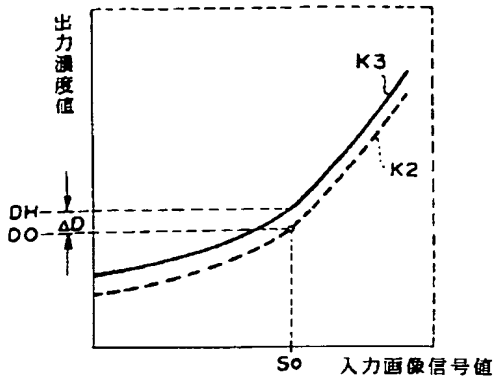

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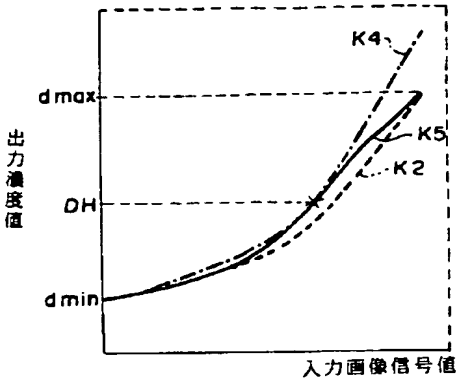

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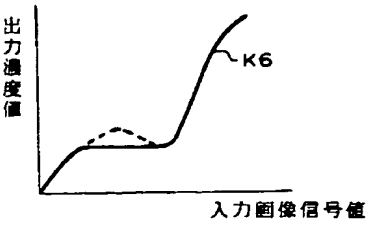

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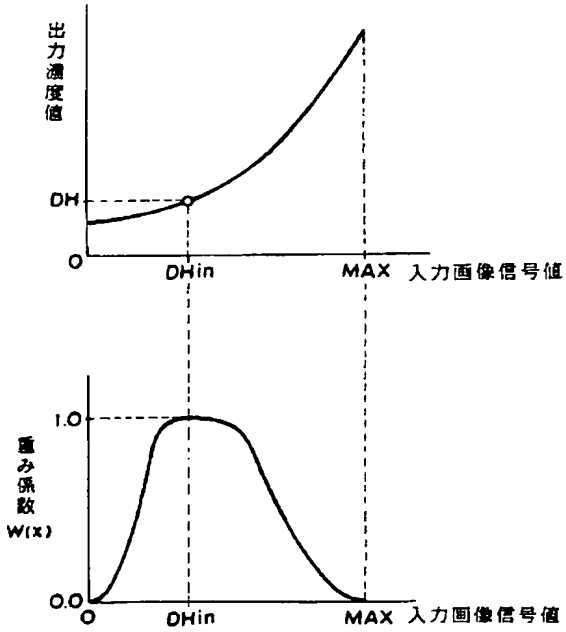

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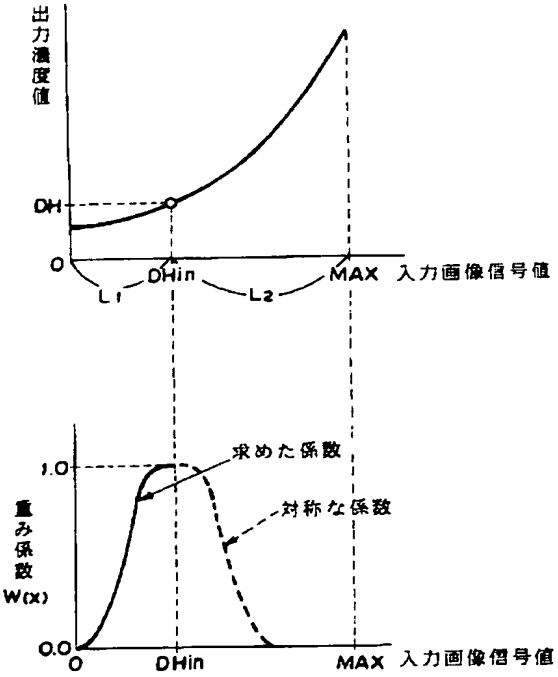

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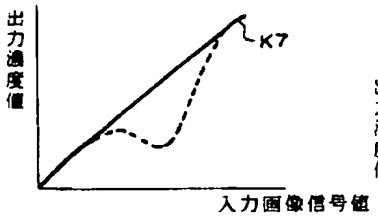

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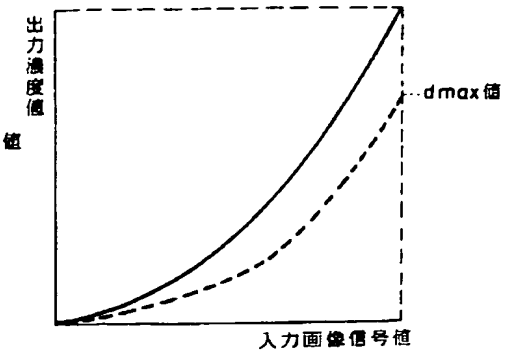

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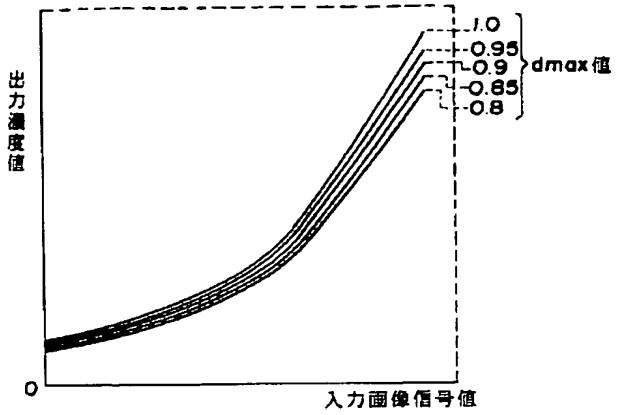

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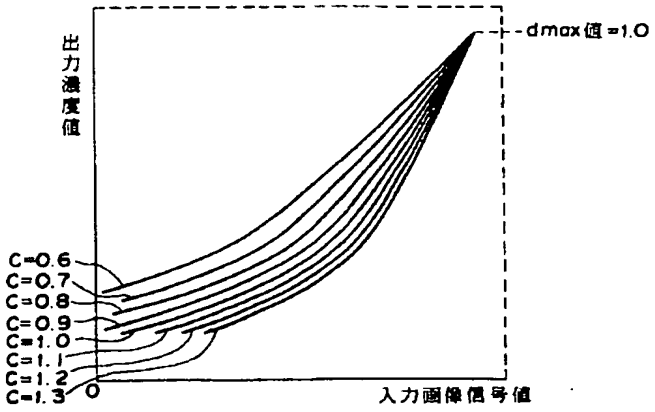

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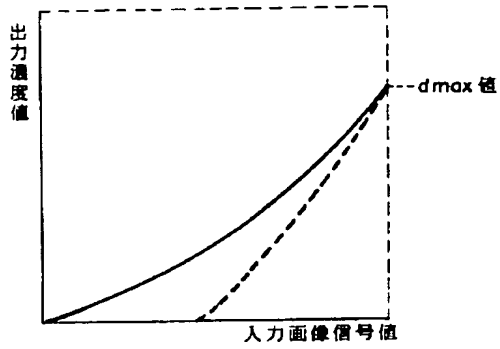

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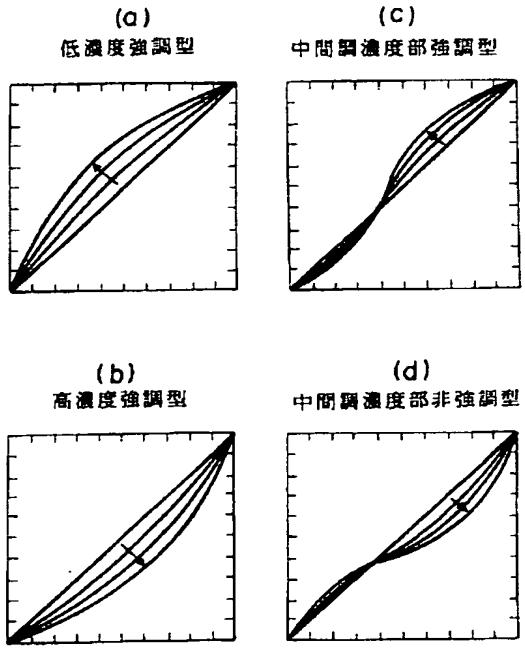

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CLAIMS

[Claim(s)]
[Claim 1] In the gradation amendment approach in the image recording playback approach which carries out record playback as a visible image with the gradation which considers as a request the picture signal which supports image information based on the gradation curve which obtains the gradation curve which amends the basic gradation curve used as criteria, and is considered as a request, and is considered as this request In the signal level-concentration system of coordinates which consist of the concentration shaft and signal level shaft which took the concentration of said good visual image on one shaft of rectangular coordinates, and took the level of said picture signal on the shaft of another side The least concentration and maximum density of said basic gradation curve expand and contract this basic gradation curve in accordance with said concentration shaft so that it may become the request least concentration and request maximum density. It centers on the point corresponding to said request concentration on the basic gradation curve which was made to move this basic gradation curve in parallel with said concentration shaft so that the point corresponding to the predetermined concentration on the this basic gradation curve expanded and contracted may serve as concentration considered as a request, and was this moved. Predetermined include-angle rotation of this basic gradation curve is carried out so that this point may serve as contrast considered as a request. So that the least concentration and maximum density of the this basic gradation curve which rotated may turn into said request least concentration and said request maximum density, respectively and the point corresponding to said predetermined concentration may serve as the concentration and contrast which are considered as said request The gradation amendment approach characterized by obtaining the gradation curve considered as a request by adding said basic gradation curve expanded and contracted and said basic gradation curve which rotated with weight with a predetermined weighting multiplier.
[Claim 2] The gradation amendment approach according to claim 1 characterized by setting up said predetermined weighting multiplier so that said request gradation curve may touch said basic gradation curve which rotated smoothly at the point corresponding to said request concentration.
[Claim 3] The gradation amendment approach according to claim 1 or 2 characterized by setting up said predetermined weighting multiplier so that said request gradation curve

may touch smoothly said basic gradation curve expanded and contracted at the point corresponding to said request least concentration and said request maximum density.
[Claim 4] The gradation amendment approach according to claim 1, 2, or 3 characterized by for said basic gradation curve choosing one basic gradation curve among those with two or more, and these two or more basic gradation curves, and performing telescopic motion of one this chosen basic gradation curve, migration, rotation, and weighting addition.
[Claim 5] The gradation amendment approach of four given in any 1 term from claim 1 characterized by repeating telescopic motion of this basic gradation curve, migration, rotation, and weighting addition by making said request gradation curve into said basic gradation curve.
[Claim 6] In the gradation compensator in the image recording regenerative apparatus which carries out record playback as a visible image with the gradation which considers as a request the picture signal which supports image information based on the gradation curve which obtains the gradation curve which amends the basic gradation curve used as criteria, and is considered as a request, and is considered as this request In the signal level-concentration system of coordinates which consist of the concentration shaft and signal level shaft which took the concentration of said good visual image on one shaft of rectangular coordinates, and took the level of said picture signal on the shaft of another side The least concentration and maximum density of a basic gradation curve which were memorized by a basic gradation storage means to memorize the basic gradation curve used as criteria, and this basic gradation curvilinear storage means A flexible means to expand and contract this basic gradation curve in accordance with said concentration shaft so that it may become the request least concentration and request maximum density, The migration means to which this basic gradation curve is moved in parallel with said concentration shaft so that the point corresponding to the predetermined concentration on the basic gradation curve expanded and contracted by this flexible means may serve as concentration considered as a request, It centers on the point corresponding to said request concentration on the basic gradation curve moved by this migration means. A rotation means to carry out predetermined include-angle rotation of this basic gradation curve so that this point may serve as contrast considered as a request, So that the least concentration and maximum density of a basic gradation curve which were rotated with this rotation means may turn into said request least concentration and said request maximum density, respectively and the point corresponding to said predetermined concentration may serve as the concentration and contrast which are considered as said request The gradation compensator characterized by consisting of a weighting addition means to add said basic gradation curve expanded and contracted and said basic gradation curve which rotated with weight with a predetermined weighting multiplier.
[Claim 7] The gradation compensator according to claim 6 characterized by being a means to set up said predetermined weighting multiplier so that said weighting addition

means may touch said basic gradation curve which rotated smoothly at the point corresponding to said request concentration.

[Claim 8] The gradation compensator according to claim 6 or 7 characterized by being a means to set up said predetermined weighting multiplier so that said weighting addition means may touch smoothly said basic gradation curve expanded and contracted at the point corresponding to said request least concentration and said request maximum density.

[Claim 9] The gradation compensator according to claim 7, 8, or 9 characterized by said basic gradation curvilinear storage means being a means which memorized two or more basic gradation curves.

[Claim 10] A gradation compensator given [claim / 6 / carry out having had further the control means which establishes further a request gradation storage means memorize said request gradation curve, inputs into said flexible means the request gradation curve memorized by this request gradation storage means, and repeats again in telescopic motion by said flexible means, migration by said migration means, the rotation by said rotation means, and the weighting addition by said weighting means as the description / nine] in any 1 term.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] In case it reproduces as a visible image based on the gradation curve which considers the picture signal which supports image information as a request, this invention relates to the gradation amendment approach and equipment which obtain the gradation curve which amends the gradation curve used as criteria and is considered as a request so that this visible image may be reproduced by the image of legible gradation according to the purpose.

[0002]

[Description of the Prior Art] Photosensitive material is exposed with the light modulated based on the picture signal, and the image recording equipment which carries out playback record of the image is used for this photosensitive material in various fields.

[0003] For example, an X-ray picture is recorded using a film with the low gamma value designed so that a next image processing might be suited. By reproducing a visible image on a sensitive film using an image recording regenerative apparatus, after reading an X-ray picture in the film with which this X-ray picture was recorded, changing into an electrical signal and performing an image processing to this electrical signal (picture signal) The system which can obtain the good playback image of image quality engine performance, such as contrast, sharpness, and graininess, is developed (refer to JP,61-5193,B).

[0004] Moreover, if radiations (an X-ray, alpha rays, beta rays, a gamma ray, an electron

ray, ultraviolet rays, etc.) are irradiated, a part of this energy of radiation will be accumulated by these people. The accumulative fluorescent substance (photostimulable phosphor) in which accelerated-phosphorescence luminescence is shown according to the energy accumulated when excitation light, such as the light, was irradiated after that is used. Photography record of the radiation image of the photographic subject of the body etc. is once carried out at an accumulative sheet-like fluorescent substance. Scan this accumulative fluorescent substance sheet with excitation light, such as laser light, and accelerated-phosphorescence luminescence light is made to produce. The obtained accelerated-phosphorescence luminescence light is read in photoelectricity, a picture signal is acquired, and the radiation image recording regeneration system which outputs the radiation image of a photographic subject as a visible image on a sensitive film based on this picture signal using an image recording regenerative apparatus is already proposed (JP,55-12429,A etc.).

[0005] In the system mentioned above, the gradation amendment pattern which is a concentration-picture signal conversion pattern which is adapted for the object photoed beforehand and each purpose is created, and gradation processing is performed in many cases by performing signal transformation processing according to this pattern to the picture signal which supports image information.

[0006] However, in creating the gradation correction curve according to a various photography object and the various various purposes in the above-mentioned gradation processing, about dozens of kinds of this gradation correction curve are needed, and the storage capacity of the rough data collection effort for creating this gradation correction curve, the computer for carrying out digital conversion and making it memorize, etc. will become huge, and cannot say it as a practically simple approach.

[0007] For this reason, in the signal level-concentration coordinate which took the concentration of this visible image on one shaft of rectangular coordinates, and took the level of this picture signal on the shaft of another side, the gradation curve used as criteria is created and the gradation amendment approach of obtaining rotation and the desired gradation curve carrying out a parallel displacement and corresponding to predetermined image information and the predetermined purpose is proposed in this curve focusing on one on a curve in these system of coordinates.

[0008] Moreover, in order to obtain various gradation curves as shown in drawing 15 and drawing 16, the gradation amendment approach of having made it change the overall concentration and the contrast of a criteria gradation curve so that it might become the gradation curve which has extent of the curve configuration and the formation of a form status change which the gradation curve used as criteria considers as a request is proposed.

[0009] By this approach, as shown in drawing 17, a basic gradation curve (a continuous line shows) is made to expand and contract in accordance with an input picture signal shaft, as it is shown in drawing 18, after expanded and contracting in accordance with a concentration shaft (a broken line shows), contrast was changed, and the gradation curve considered as a request by this has been obtained.

[0010] Furthermore, as shown in drawing 19, some characteristic basic gradation is prepared, the thing near desired gradation out of it is chosen, and the method of obtaining the gradation considered as a request is proposed by changing whenever [emphasis / of the selected gradation] (extent of the knee condition of a gradation curve). Whenever [emphasis / of gradation] can be changed by this approach, without changing maximum density and the least concentration (JP,5-323750,A).

[0011]

[Problem(s) to be Solved by the Invention] In case the picture signal mentioned above was reproduced as a visible image, the request of wanting to obtain the image of the gradation considered as a request was large by adjusting the gradation curve amended by the gradation amendment approach, setting up the maximum density and the least concentration of a playback image, or changing the partial concentration and the contrast of a playback image.

[0012] However, it sets to the approach of amending a gradation curve by adjusting the overall contrast and the concentration of a criteria gradation curve which were mentioned above. Since the maximum density and the least concentration of a gradation curve after amendment change upwards and partial amendment of a gradation curve cannot be performed, while making the image reproduced into the thing of the range of predetermined concentration The concentration and contrast of only a part of concentration which are considered as the request of an image were not able to be changed. Moreover, by the approach of fixing the maximum density and the least concentration of a gradation curve which were indicated by JP,5-323750,A mentioned above, and changing an overall knee condition of a gradation curve, although the maximum density and the least concentration of a gradation correction curve after amendment do not change, they were not able to change a part of concentration and contrast of a playback image.

[0013] In view of the above-mentioned situation, this invention aims at offering the gradation amendment approach and equipment which can perform adjustment of partial concentration and contrast while it can set up the maximum density and the least concentration of a playback image.

[0014]

[Means for Solving the Problem] The gradation curve which the gradation amendment approach by this invention amends the basic gradation curve used as criteria, and is considered as a request is obtained. In the gradation amendment approach in the image recording playback approach which carries out record playback as a visible image with the gradation which considers as a request the picture signal which supports image information based on the gradation curve considered as this request In the signal level-concentration system of coordinates which consist of the concentration shaft and signal level shaft which took the concentration of said good visual image on one shaft of rectangular coordinates, and took the level of said picture signal on the shaft of another side The least concentration and maximum density of said basic gradation curve expand and contract this basic gradation curve in accordance with said concentration shaft so that

it may become the request least concentration and request maximum density. It centers on the point corresponding to said request concentration on the basic gradation curve which was made to move this basic gradation curve in parallel with said concentration shaft so that the point corresponding to the predetermined concentration on the this basic gradation curve expanded and contracted may turn into a point corresponding to the concentration considered as a request, and was this moved. Predetermined include-angle rotation of this basic gradation curve is carried out so that this point may serve as contrast considered as a request. So that the least concentration and maximum density of the this basic gradation curve which rotated may turn into said request least concentration and said request maximum density, respectively and the point corresponding to said request concentration may serve as the concentration and contrast which are considered as said request It is characterized by obtaining the gradation curve considered as a request by adding said basic gradation curve expanded and contracted and said basic gradation curve which rotated with weight with a predetermined weighting multiplier.

[0015] Here, a gradation curve is a characteristic curve showing correspondence of the picture signal level which carried out photo electric conversion of the brightness of the photographic subject over the optical density of the last playback image, and it is usually used in the field treating an image.

[0016] Moreover, the gradation compensator by this invention is for enforcing the above-mentioned approach. In the gradation compensator in the image recording regenerative apparatus which carries out record playback as a visible image with the gradation which considers as a request the picture signal which supports image information based on the gradation curve which obtains the gradation curve which amends the basic gradation curve used as criteria, and is considered as a request, and is considered as this request In the signal level-concentration system of coordinates which consist of the concentration shaft and signal level shaft which took the concentration of said good visual image on one shaft of rectangular coordinates, and took the level of said picture signal on the shaft of another side The least concentration and maximum density of a basic gradation curve which were memorized by a basic gradation storage means to memorize the basic gradation curve used as criteria, and this basic gradation curvilinear storage means A flexible means to expand and contract this basic gradation curve in accordance with said concentration shaft so that it may become the request least concentration and request maximum density, The migration means to which this basic gradation curve is moved in parallel with said concentration shaft so that the point corresponding to the predetermined concentration on the basic gradation curve expanded and contracted by this flexible means may serve as concentration considered as a request, It centers on the point corresponding to said request concentration on the basic gradation curve moved by this migration means. A rotation means to carry out predetermined include-angle rotation of this basic gradation curve so that this point may serve as contrast considered as a request, So that the least concentration and maximum density of a basic gradation curve which were rotated with this rotation means may turn into said request least concentration and

said request maximum density, respectively and the point corresponding to said request concentration may serve as the concentration and contrast which are considered as said request It is characterized by consisting of a weighting addition means to add said basic gradation curve expanded and contracted and said basic gradation curve which rotated with weight with a predetermined weighting multiplier.

[0017] Furthermore, in the above-mentioned approach and equipment, it is desirable to set up said predetermined weighting multiplier so that said request gradation curve may touch said basic gradation curve which rotated smoothly at the point corresponding to said request concentration, and it is still more desirable to set up said predetermined weighting multiplier so that said request gradation curve may touch further said basic gradation curve expanded and contracted smoothly at the point corresponding to said request least concentration and said request maximum density.

[0018] Moreover, a storage means is made to carry out two or more storage of said basic gradation curve, one basic gradation curve is chosen among these two or more basic gradation curves, and it may be made to perform telescopic motion of one this chosen basic gradation curve, migration, rotation, and weighting addition.

[0019] Furthermore, you may make it repeat telescopic motion of this basic gradation curve, migration, rotation, and weighting addition by making said request gradation curve into said basic gradation curve.

[0020]

[Function] The gradation amendment approach and equipment by this invention expand and contract this basic gradation curve so that the least concentration and maximum density of a basic gradation curve which are to the base which performs gradation amendment may turn into the request least concentration and request maximum density. The point corresponding to the predetermined concentration which should be made the object of observation of this basic gradation curve expanded and contracted This curve is moved and rotated so that it may become desired concentration and contrast. So that the least concentration and maximum density of a basic gradation curve which were rotated may turn into the request least concentration and request maximum density and the point corresponding to request concentration may serve as request concentration and contrast It is made to carry out weighting addition of the basic gradation curve expanded and contracted and the basic gradation curve which rotated with a predetermined weighting multiplier. And by amending a basic gradation curve by carrying out weighting addition so that the weighting multiplier of the basic gradation curve which the weighting multiplier of the basic gradation curve expanded and contracted in the point of the minimum level of the signal value of a gradation curve and a record level rotated in the point of 1 and request concentration may be set to 1 The gradation curve obtained turns into a curve on which maximum density and the least concentration have the contrast considered as the concentration which turns into request maximum density and the request least concentration, and the partial point corresponding to request concentration considers as a request, and a request.

[0021] Therefore, if a picture signal is reproduced as a visible image based on this request gradation curve, the point corresponding to the predetermined concentration which a playback image has in the range of the request least concentration and request maximum density, and is set as the object of observation will be reproduced by the contrast considered as the concentration and the request which are considered as a request.
[0022] Moreover, since the gradation curve considered as a request according to the class of picture signal acquired by photography can be set up even if it is the case where the objects photoed [image / the image obtained not only when reproducing the radiation image mentioned above, but by tomography, / electron microscope] differ, the image of the gradation considered as a request is reproducible irrespective of the class of playback image.
[0023] Moreover, as the basic gradation curve and the request gradation curve which rotated in the point of request concentration and/or the point of the request least concentration and request maximum density touch smoothly, the basic gradation curve and the basic gradation curve which rotated expanded and contracted by setting up a weighting multiplier will touch smoothly, and the visible image reproduced based on this gradation curve will become natural [a visual impression].
[0024] Furthermore, the width of face of selection of the basic gradation curve which should amend will spread by preparing two or more basic gradation curves, and choosing from two or more of these basic gradation curves the basic gradation curve which should carry out amendment.
[0025] Moreover, since it can consider as the concentration and contrast which consider a request gradation curve as a request further by performing repeat amendment by making the amended request gradation curve into a basic gradation curve, the image reproduced by this amendment gradation curve becomes what was more suitable for observation.
[0026]
[Example] With reference to a drawing, the example of this invention is explained below.
[0027] Drawing 1 is a block diagram explaining the outline of the gradation amendment approach by this invention, and equipment. As shown in drawing 1 , the gradation amendment approach and equipment by this invention In the signal level-concentration system of coordinates which consist of the concentration shaft and signal level shaft which took the concentration of a visible image on one shaft of rectangular coordinates, and took the level of a picture signal on the shaft of another side The least concentration and maximum density of a basic gradation curve which were memorized by a basic gradation storage means 1 to memorize the basic gradation curve used as criteria, and the basic gradation curvilinear storage means 1 A flexible means 2 to expand and contract a basic gradation curve in accordance with a concentration shaft so that it may become the request least concentration and request maximum density, The migration means 3 to which a basic gradation curve is moved in parallel with a concentration shaft so that the point corresponding to the predetermined concentration on the basic gradation curve expanded and contracted by the flexible means 2 may serve as concentration considered as a request,

It centers on the point corresponding to the request concentration on the basic gradation curve moved by the migration means 3. A rotation means 4 to carry out predetermined include-angle rotation of the basic gradation curve so that this point may serve as contrast considered as a request, So that the least concentration and maximum density of a basic gradation curve which were rotated with the rotation means 4 may turn into the request least concentration and request maximum density which were mentioned above, respectively and the point corresponding to request concentration may serve as the concentration and contrast which are considered as a request It consists of a weighting addition means 5 to add the basic gradation curve expanded and contracted and the basic gradation curve which rotated with weight with a predetermined weighting multiplier. The basic gradation storage means 1 mentioned above, the flexible means 2, the migration means 3, the rotation means 4, and the weighting addition means 5 amend a basic gradation curve, and the gradation curve 6 considered as a request is obtained.

[0028] The outline of the gradation compensator by the example of this invention is explained below.

[0029] Drawing 2 is drawing showing an example of radiation image photography equipment.

[0030] Radiation 12a for which the radiation 12 was irradiated towards the photographic subject 13 of the body etc. from the radiation source 11 of this radiation image photography equipment 10 and which penetrated the photographic subject 13 When the accumulative fluorescent substance sheet 14 irradiates, are recording record of the transparency radiation image of a photographic subject 13 is carried out at a sheet 14.

[0031] Drawing 3 is a perspective view showing an example of a radiation image reader.

[0032] The accumulative fluorescent substance sheet with which are recording record of a radiation image was performed as mentioned above is set to the predetermined location of this radiation image reader.

[0033] The accumulative fluorescent substance sheet 14 set to the predetermined location is conveyed in the direction of arrow-head Y by the sheet conveyance means 15, such as an endless belt driven by the driving means which is not illustrated, (vertical scanning). the mirror 21 after a reflective deviation being carried out by the rotating polygon 19 which drives the light beam 17 emitted from the laser light source 16 by the motor 18, and carries out high-speed rotation at an arrow-head Z direction and, passing the focusing lenses 20, such as ftheta lens, by it on the other hand -- an optical path -- changing -- a sheet 14 -- incidence -- carrying out -- the direction of vertical scanning (the direction of arrow-head Y), and abbreviation -- horizontal scanning is carried out in the right-angled direction of arrow-head X. From the part where the light beam 17 of a sheet 14 was irradiated, the accelerated-phosphorescence luminescence light 22 of the quantity of light according to the radiation image information by which are recording record is carried out is emitted, and this accelerated-phosphorescence luminescence light 22 is drawn with lightguide 23, and is detected by the photomultiplier (photomultiplier tube) 24 in photoelectricity. Lightguide 22 is incidence end-face 23a which fabricates light guide nature ingredients, such as an

acrylic board, is made, and makes the shape of a straight line. Injection end-face 23b which was allotted so that the horizontal-scanning line on the accumulative fluorescent substance sheet 14 might be met and it might extend, and was formed in the shape of a circular ring The light-receiving side of a photomultiplier 24 is combined. incidence end-face 23a from -- the accelerated-phosphorescence luminescence light 22 which carried out incidence into lightguide 23 -- the interior of this lightguide 23 -- total reflection -- repeating -- progressing -- injection end-face 23b from -- it injects, light is received by the photomultiplier 24 and the accelerated-phosphorescence luminescence light 22 showing a radiation image is changed into an electrical signal by the photomultiplier 24.

[0034] analog signal S outputted from the photomultiplier 24 -- logarithmic amplifier 25 -- a logarithm -- it is inputted into back A/D converter 26 amplified-like, samples with the time interval corresponding to the predetermined sampling period on the accumulative fluorescent substance sheet 14, and is changed into the digital image data S1. Once this image data S1 is memorized by the storage section 27, it is sent to an image processing system 28.

[0035] This image processing system 28 connotes an example of the gradation compensator of this invention. That is, the basic gradation storage means 1 shown in drawing 1 mentioned above, the flexible means 2, the migration means 3, the rotation means 4, and the weighting addition means 5 are connoted, and the input of the concentration from the input means 29, contrast, etc. performs processing in each means.

[0036] Drawing 4 is drawing showing an example of the basic gradation curve memorized by the basic gradation storage means 1 of an image processing system 28. As shown in drawing 4 , the basic gradation curve K1 is set up in the signal level-concentration system of coordinates which consist of the concentration shaft and signal level shaft which took the concentration value of a visible image along the axis of ordinate, and took the level of a picture signal along the axis of abscissa, and obtains the gradation curve considered as a request by amending the basic gradation curve K1 shown in drawing 4 in this example.

[0037] First, in the flexible means 2, telescopic motion of the basic gradation curve K1 is made. That is, as shown in drawing 5 , it is the maximum density Dmax of the basic gradation curve K1. And the least concentration Dmin Request maximum density dmax inputted from the input means 29 And the request least concentration dmin The basic gradation curve K1 is expanded and contracted in accordance with a concentration shaft, and the basic gradation curve K2 expanded and contracted is obtained so that it may become.

[0038] Subsequently, in the migration means 3, the basic gradation curve K2 is moved in parallel with a concentration shaft so that the point corresponding to the predetermined concentration on the basic gradation curve K2 expanded and contracted by the flexible means 2 may serve as concentration considered as a request. First, while inputting the concentration value D0 corresponding to the image concentration considered as a request from the input means 29, the concentration DH of choice of this concentration value D0 is inputted. The basic gradation curve K3 which movement magnitude deltaD for moving the

basic gradation curve K2 expanded and contracted based on this inputted concentration value D0 and the concentration value DH of choice in the migration means 3 in parallel with a concentration shaft was calculated, was made to move the basic gradation curve K2 expanded and contracted as shown in drawing 6 , and was moved is obtained. Moreover, the input approach of a concentration value is not restricted to this, and you may make it input difference deltaD of the concentration value D0 and the concentration value DH of choice.

[0039] Subsequently, in the rotation means 4, predetermined include-angle rotation of the basic gradation curve K3 moved so that it might become the contrast which this point considers as a request a core [the point corresponding to the request concentration on the basic gradation curve K3 moved by the migration means 3] is carried out. That is, rotation deltaalpha of the basic gradation curve K3 first moved from the input means 29 is inputted. In the rotation means 4, deltaalpha rotation of the basic gradation curve K3 moved as shown in drawing 7 based on this inputted rotation deltaalpha is done a core [the point P corresponding to request concentration], and the basic gradation curve K4 which rotated is obtained.

[0040] Subsequently, the least concentration and the maximum density of the basic gradation curve K4 which were rotated with the rotation means 4 in the weighting addition means 5 are the request least concentration dmin, respectively. And request maximum density dmax Weighting addition of the basic gradation curve K2 expanded and contracted and the basic gradation curve K4 which rotated is carried out with a predetermined weighting multiplier so that it may become and the point P corresponding to request concentration may serve as the concentration DH and the contrast which are considered as a request. namely, -- if the gradation curve obtained by weighting addition with the basic gradation curve K2 expanded and contracted and the basic gradation curve K4 which rotated is made into K5 K5=WxK4+(1-W) xK2 -- (1) however -- W: -- the operation of a weighting factor should do -- gradation curvilinear K5 is obtained. Here, what is shown in drawing 9 as an example of weighting-factor W is mentioned. And weighting-factor W is used in the weighting addition means 5, and it is a formula (1). The shown operation is made and gradation curvilinear K5 as shown in drawing 8 is obtained.

[0041] Here, for weighting-factor W, the least concentration and maximum density of the basic gradation curve K4 which were rotated with the rotation means 4 are the request least concentration dmin, respectively. And request maximum density dmax It becomes. And so that the point P corresponding to request concentration may serve as the concentration DH and contrast which are considered as a request Near point P, the weight of the gradation curve K4 is large, and it is set up so that the weight of the gradation curve K2 may become large maximum density and near the least concentration. And it is set up so that gradation curvilinear K5 may touch the gradation curve K4 smoothly near point P, and the gradation curve K2 may be smoothly touched maximum density and near the least concentration and change of a weighting multiplier may continue. Thus, by changing a weighting multiplier continuously, the visible image reproduced based on the amended

gradation curve will become natural [a visual impression].

[0042] Here explains the approach of a setup of the weighting multiplier W. In addition, the concentration and contrast which explained and changed the example in the case of asking for a weighting factor using the 4th polynomial shall cover all the range of gradation 5, and shall do effect here. As shown in drawing 10, input digital value over the concentration of choice (DH) is set to (DHin), and each input digital value is set to x. At this time, weighting-factor W (x) is decided in the section of x<DHin and DHin<x, respectively. The determining condition of the weighting factor in each section is as follows.

[0043]

At the time of x<DHin DHin<x W(0) =0 .... 1. .. W(DHin) =1 W(DHin) = 1 .... 2. .. W(MAX) =0 W'(0) =0 .... 3. .. W'(DHin) =0 W'(DHin) =0 .... 4. .. W'(MAX) =0 W"(k1) =0 ..5... W" (k2) =0 (0<k1<DHin) (DHin<k2<MAX)

Condition 5. for condition 3.4. for filling the influence of the gradation curve K4 of the gradation curve K2 to which the semantics of such conditional expression stated 1.2. previously to make smooth gradation is the conditions for the degree adjustment of effect which the changed concentration and contrast exert on gradation curvilinear K5. In the conditional expression of 5., if k1 and k2 are made into the DHin side, the range where the influence of gradation curvilinear K5 is strong will become narrow.

[0044] Although the concentration and contrast which were changed had affected all the range of gradation curvilinear K5 in this example, a setup of the weighting factor which limited the range where this effect reaches can also be performed. This example is explained using drawing 11. It is the range from L1 and DHin to MAX about the range from 0 to now and DHin L2 It carries out. At this time, it is the range L1 and L2. It asks for a multiplier with the narrower range, and a symmetrical multiplier is set up by DHin about the multiplier of another side. When setting up such a weight function and a change of contrast is made to the concentration of the part extremely near the minimum (max) concentration, the situation where the effect will attain to even the maximum (min) concentration side can be avoided, and local gradation can be changed. The weighting factor of drawing 9 shown previously is this example.

[0045] Although the two above-mentioned examples are the approaches of asking for a multiplier using the 4th polynomial, the method of asking for a weighting factor is not restricted to this, and may use other polynomials, a trigonometric function, an exponential function, etc.

[0046] Moreover, the count approach of basic gradation curvilinear K5 is not only weighting addition but [0047].

[Equation 1]

[0048] ** ·· a formula [like] is sufficient and it is good the anything which can change a synthetic ratio depending on an input value.

[0049] Thus, if gradation curvilinear K5 considered as a request is obtained, based on gradation curvilinear K5 of an image processing system 28 smell lever, a picture signal S1 is processed, and the processed picture signal S2 will be changed into the playback means 30, such as a laser beam printer and CRT, and will be reproduced as a visible image in this playback means 30.

[0050] In addition, gradation curvilinear K5 considered as the request called for in the example mentioned above is memorized for the storage means 27, and it may be made to perform processing in the flexible means 2 which mentioned this gradation curvilinear K5 above as basic gradation, the migration means 3, the rotation means 4, and the weighting addition means 5. In this case, it is possible to amend so that it may become the concentration and contrast which consider the point of different level from the point corresponding to the Sadanobu Tokoro number level set up by the last amendment as amendment for the second time as a request. Moreover, if it is made to repeat the processing in this flexible means 2, the migration means 3, the rotation means 4, and the weighting addition means 5, the gradation curve near [it is infinite to the gradation of the ideal considered as a request, and] it can be created.

[0051] Moreover, in this invention, when it is going to amend extreme gradation, the phenomenon in which an output concentration value does not become the increment in monotone to an input picture signal value as shown in drawing 12 may happen. In such a case, measures with which gradation curvilinear K5 after amendment serves as an increment in monotone are taken. For example, how to make into constant value the output concentration value of the section which the concentration value has reversed as shown in drawing 13, and to obtain the gradation curve K6, the method of changing the section order which the output concentration value reversed as shown in drawing 14 in a straight line, and obtaining the gradation curve K7, etc. can be considered. Of course, as the approach of a cure, it is not limited to these, and as long as it is the approach of correcting gradation curvilinear K5 so that it may become the increment in monotone, what kind of approach may be used.

[0052] Moreover, although amendment of the gradation curve in the case of recording a radiation image on an accumulative fluorescent substance sheet, acquiring the picture signal with which a radiation image is expressed from this accumulative fluorescent substance sheet in the example mentioned above, and performing gradation processing to this picture signal was explained You may make it amend the gradation curve in the case of performing gradation processing not to the thing limited to this but to the picture signal acquired by reading an X-ray picture in the film with which the X-ray picture was recorded. Moreover, you may make it amend the gradation curve in the case of performing gradation processing to the picture signal acquired by tomography, such as CAT, and the picture signal showing the electron microscope image obtained by photography of an electron

[Description of Notations]
1 Basic Gradation Curvilinear Storage Means
2 Flexible Means
3 Migration Means
4 Rotation Means
5 Weighting Addition Means
6 Request Gradation Curve
K1 Basic gradation curve
K2 Gradation curve expanded and contracted
K3 Moved gradation curve
K4 Gradation curve which rotated
K5 Gradation curve by which weighting addition was carried out

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[Translation done.]